Virtual National Laboratory for Heavy Ion Fusion

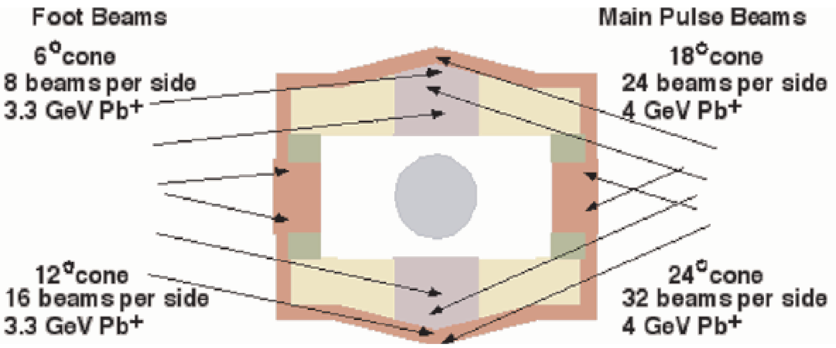
September 2002

HIF News

LBNL-PUB-844-02-09

New target design consistent with neutron-shielded final focus design

Recent work on an integrated, heavy ion fusion power plant point design has suggested that the ion beams may need to enter the target from larger angles than had been previously assumed. This is because more neutron shielding is needed inside the final focus magnets than previous estimates had indicated. In order to accommodate these larger beam angles, we have modified the distributed radiator target to accept beams at angles up to 24°. The point design achieved gain of 55 from 6.4 MJ of ion beam energy. This design is not yet optimal—we expect to achieve gain 62 from 6.4 MJ. To accommodate the larger angles, the hohlraum wall area was increased and resulted in an energy penalty of 500 kJ over the previous distributed radiator target. The beams were assumed to enter in four rings with a minimum angle of 6° and a maximum angle of 24°. To get acceptable time-dependent symmetry at the capsule, the inner two rings of beams were used for the foot beams and the outer two rings were used for the main pulse beams. Using the shallow angles for the foot beams allowed a 30% larger beam spot in the foot than the main pulse. This is in a direction consistent with chamber transport simulations which show that the foot beams may be larger than the main pulse beams because they do not benefit from neutralization due to photo-ionization of the chamber gas near the target. – *Debbie Callahan*



Initial experimental success with arrays of liquid jets for IFE chambers

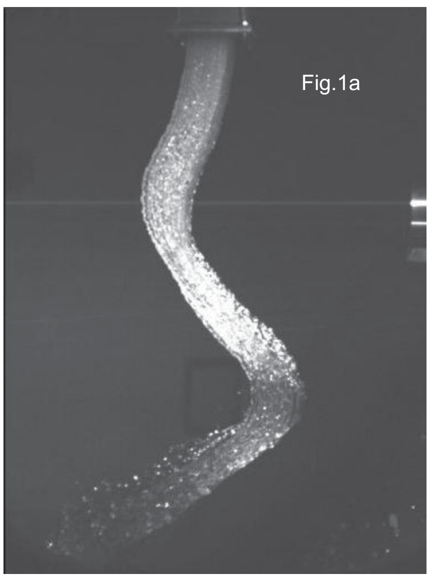


Fig.1a

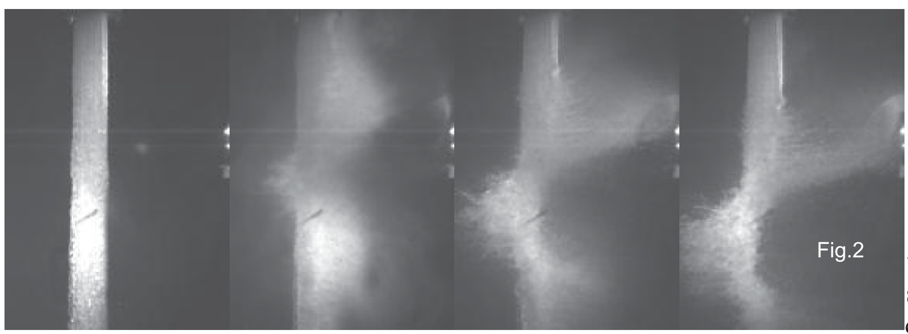


Fig.2

Thick-liquid-wall inertial-fusion-energy (IFE) chambers use arrays of liquid jets to shield the vacuum wall from neutron and gamma radiation, target debris, and shock waves; and to clear droplets from the chamber center before target injection. Work in the UC Berkeley Vacuum Hydraulics Experiment (VHEX) has demonstrated the formation of a liquid slab jet array with 50% void fraction that demonstrates two encouraging features: (1) It remains coherent during transverse oscillation (Fig. 1a), and (2) it delays the transmission of impulse momentum through the jet structure and strongly dissipates the shock kinetic energy—where a full-density liquid jet of the same mass would transmit a strong shock through the jet liquid almost immediately. (Fig. 2).

The slab jet is created at one-quarter the prototypical scale from 94 cylindrical jets and a single sheet jet (Fig. 1b). Appropriate flow conditioning is used to adjust all jets to the same velocity, which is necessary to prevent jets in an oscillating array from colliding. The degree of coherence shown for the oscillating jet array (Fig. 1a) indicates that equal jet velocities were achieved. .

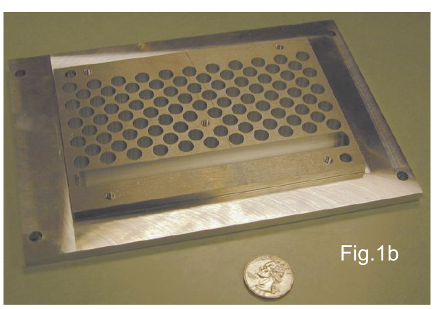


Fig.1b

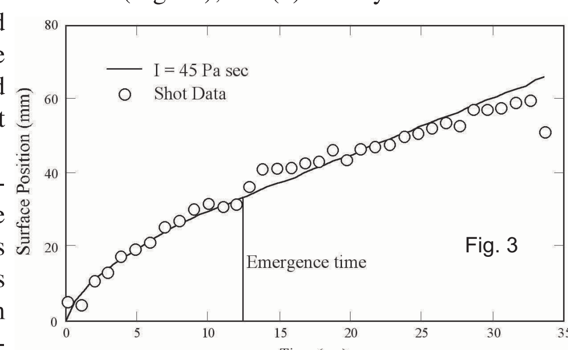


Fig. 3

Experimental disruption of the slab is accomplished by delivering a gas impulse to the thin sheet, as displayed in Fig. 2. Simple "snowplow" theory predicts that void collapse in the slab jet can delay transmission of the impulse through the slab by as much as three times the oscillation period. Vacuum experiments have been conducted with a stationary slab in VHEX, and high-speed photographic data upholds the simple theory (Fig. 3). Therefore, the use of such voided-liquid slabs allows disrupted liquid to leave the chamber center before significant impulse is delivered to the chamber wall, and this in turn prevents damage to first-wall materials by high-velocity liquid slugs. *Steve Pemberton and Per Peterson*

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This work was performed under the auspices of the U.S. Department of Energy by the University of California Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48 and by Lawrence Berkeley National Laboratory under contract No. DE-AC03-76SF00098 (LBNL), and by Princeton Plasma Physics Laboratory performed under the auspices of the U.S. Department of Energy under contract No.DE-AC02-76CH-O3073.